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Tongue color changes within a menstrual cycle in eumenorrheic women

Shu-Feng Hsieh^a, Li-Ling Shen^b, Shan-Yu Su^{b, c, *}^a Department of Traditional Chinese Medicine, Kaohsiung Veterans General Hospital, Kaohsiung 81362, Taiwan^b Department of Chinese Medicine, China Medical University Hospital, Taichung 40447, Taiwan^c School of Post-Baccalaureate Chinese Medicine, College of Chinese Medicine, China Medical University, Taichung 40402, Taiwan

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ABSTRACT

Tongue color (舌色 shé sè) has been used to diagnose abnormal body conditions for thousands of years in traditional Chinese Medicine (中醫 zhōng yī). However, it is not clear whether tongue color alters with physiological changes within a normal menstrual cycle (月經周期 yuè jīng zhōu qī). This study investigated difference in tongue color between the follicular phase and luteal phase in eumenorrheic women. Tongue surface photographs were taken in the follicular phase and the luteal phase of thirty-two volunteers with biphasic basal body temperature. Color values on five areas of the tongue surface were examined and comparisons of color values were made between the two phases according to the red–green–blue (RGB), hue–saturation–brightness (HSB), luminance–a–b (Lab), and cyan–magenta–yellow–black (CMYK) models. Based on the RGB model, the values of green and blue in the tip area were larger in the follicular phase than both in the luteal phase. The values of magenta and yellow based in the CMYK model were smaller in the tip area in the follicular phase than that in the luteal phase. The saturation in the tip area was smaller in the follicular phase than that in the luteal phase. Based on the Lab model, b value in the middle area was smaller in the follicular phase than that in the luteal phase. The data revealed that tongue color varied within a eumenorrheic menstrual cycle, suggesting that tongue color differences between the follicular and luteal phases need to be considered while practicing tongue diagnosis (舌診 shé zhēn) or performing clinical studies among childbearing women.

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1. Introduction

Tongue diagnosis (舌診 shé zhēn) is one of “the four diagnostic methods in traditional Chinese Medicine (中醫四診 zhōng yī sì zhēn)”, which is an important subdivision of contemporary complementary and alternative medicine (CAM; 補充與替代醫學 bǔ chōng yǔ tì dài yī xué) in the world.¹ According to the textbook of

TCM, tongue color (舌色 shé sè) is a crucial component in the tongue diagnostic method, and is used traditionally to diagnose the imbalance of “Yin and Yang (陰陽 yīn yáng)”.² From the point of view of modern medicine, tongue color is dependent on microcirculation, which is changed with body temperature, hormones, and hemodynamic parameters.^{3,4} It has been reported that tongue color changes in several diseases, such as anemia,⁵ appendicitis,⁶ and immune hepatic injury.⁴ Tongue color is also used to categorize subgroups of diseases to predict the effectiveness of Chinese medicine and conventional western medicine.^{7,8} However, those studies on women of childbearing (分娩 fēn miǎn) age did not consider the effect of menstrual cycle (月經周期 yuè jīng zhōu qī) on tongue color, because the difference in tongue color between phases in a menstrual cycle has not been clarified.

Physiological parameters change within a eumenorrheic menstrual cycle in healthy women. First of all, the concentration of estradiol is high while progesterone is relatively low in the late follicular phase and the concentrations of both estradiol and

Abbreviations: B (in HSB), brightness; B (in RGB), blue; BBT, basal body temperature; CMYK, cyan–magenta–yellow–black; C, cyan; E2, estradiol; G, green; HSB, hue–saturation–brightness; H, hue; K, black; L, luminance; Lab, luminance–a–b; M, magenta; R, red; RGB, red–green–blue; S, saturation; TCM, traditional Chinese Medicine; Y, yellow.

* Corresponding author. Department of Chinese Medicine, China Medical University Hospital. No. 2 Yuh-Der Road, Taichung 40447, Taiwan. Tel.: +886 4 22052121x1675; fax: +886 4 22365141.

E-mail address: shanyusu@yahoo.com.tw (S.-Y. Su).

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progesterone are high in the luteal phase.⁹ Secondly, the high concentration of progesterone in the luteal phase induces hypothalamus thermogenic effect and elevates the basal body temperature (BBT) by about 0.22 °C compared with that in the follicular phase.¹⁰ Thirdly, in terms of hemodynamic parameters, the plasma volume, heart rate, and cardiac output are larger in the luteal phase than those in the follicular phase.^{11,12} Fourthly, the sympathetic baroreflex sensitivity is greater during the middle luteal phase than the early follicular phase.¹³ Fifthly, under static exercise, changes of muscle sympathetic nerve activity are greater in the menstrual phase than that in the follicular phase.¹⁴ The above mentioned physiological variations from the follicular to the luteal phases within a menstrual cycle could also be detected by measuring biological information. In studies which detecting heart rate variability, the total power and high frequency spectral component have been reported higher in the luteal phase than both in the follicular phase.^{15,16} Pulse waveform analysis also has revealed that the magnitude of the main wave, dicrotic wave, and systolic area of the radial pulse waveforms are greater in the luteal phase than those in the follicular phase.¹⁷ However, no reports have been published regarding differences of tongue color between phases in a menstrual cycle.

Based on the above-mentioned changes in physiological parameters within a menstrual cycle, we speculated that tongue color alters with phases in a normal menstrual cycle. In this study, tongue images of eumenorrheic women were taken in the follicular phase and luteal phase. Tongue color in five areas of the tongue was compared between the two phases based on the RGB (red–green–blue), HSB (hue–saturation–brightness), Lab (luminance-a-b), and CMYK (cyan–magenta–yellow–black) models, those are commonly used in technology of color analysis. This study provided evidence for the effect of physiological phases of menstrual cycle on tongue color in eumenorrheic women.

2. Materials and methods

2.1. Subjects

Subjects were recruited through an advertisement at the China Medical University Hospital (CMUH) between March 2009 and January 2010. All subjects received a full explanation of the study and signed an informed consent. The enrolled subjects met the following criteria: (1) eumenorrheic healthy women with regular, predictable menstrual cycles (月經周期 *yuè jīng zhōu qī*) ranging from 28 to 35 days; (2) age from 18 to 40 years; (3) no oral contraceptive use within the last 6 months; (4) no history of alcohol, drug abuse, or smoking. Exclusion criteria are: (1) active heart disease, liver disease, kidney disease, or thyroid disease; (2) any chronic disease which needs medication; and (3) psychiatric disorders. This study was approved by the institutional review board of the CMUH (DMR97-IRB-241).

2.2. Tongue photographs

Subjects were asked to measure BBT every morning and provided their BBT chart to ensure that the studied cycle was a biphasic menstrual cycle and the tongue images were taken in the correct phases. Tongue images representing the follicular phase were taken on the 12th or 13th day of the menstrual cycle, and that representing the luteal phase were taken on the 26th or 27th day of the cycle.¹⁸ All the images were taken before breakfast in the morning during nine to twelve o'clock by a charge-coupled device Nikon E2 (Nikon, Tokyo, Japan) with a lens of Micro-Nikkor 10.5 mm/2.8D (Nikon, Tokyo, Japan). After a 20 min' rest, images were taken in a standardized shady studio, which was surrounded by focusing

cloth, under a cold light supplied by a source of Raiser Repro-Belichtungseinrichtung RB 5000. The camera-to-object distance was set to be 50 cm. A shutter speed of 1/125 s was used. The photographs were taken immediately after subjects protruded their tongues forward and downward. The room temperature of the studio was set at 21 ± 1 °C.

2.3. Tongue color (舌色 *shé sè*) measurement

Tongue surface was divided into five areas as tongue tip, middle, left lateral, right lateral, and root (Fig. 1).¹⁹ Tongue tip was defined as the anterior one-fifth of the tongue, tongue root was defined as the posterior one-fifth of the tongue, tongue lateral was defined as the lateral one-fifth of the tongue on both sides, and tongue middle was defined as the area between the tongue tip, tongue root, and tongue lateral areas. The color values of R, G, and B in the RGB model, that of H, S, and B in the HSB model, that of L, a, and b in the Lab model, and that of C, M, Y, and K in the CMYK model were measured using Photoshop software (Adobe Systems Incorporated, San Jose, America). For each area, color values were measured at three randomly selected points. The color value of a certain area was the average value of these three randomly selected measurements.

2.4. Statistical analysis

Statistical analyses were performed using the SPSS 18.0 statistical software package. Individual variables were examined by percentage, mean and standard error of the mean (SEM). Differences in color parameters between the follicular and luteal phases were compared by paired *t*-test. A two-tailed *p*-value of less than 0.05 was considered to be statistically significant.

3. Result

3.1. Subjects

A total of 32 volunteers have participated in this study. All these subjects were identified to have biphasic menstrual cycle (月經周期 *yuè jīng zhōu qī*) according to their BBT charts. The mean age of the subjects was 25.7 ± 0.8 years old. They had a mean body height of

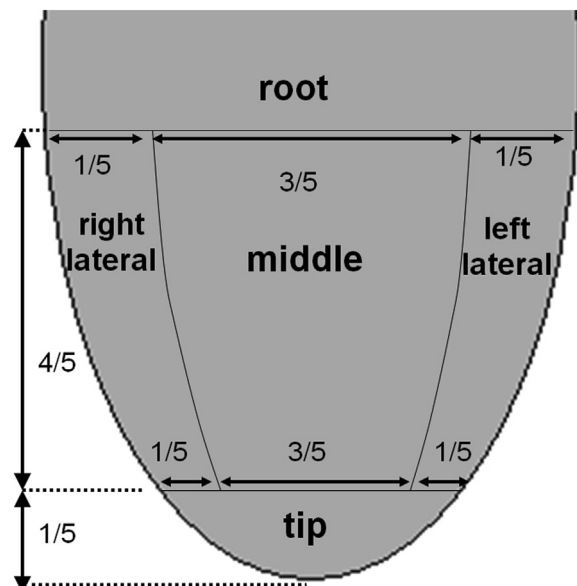


Fig. 1. Five areas of the tongue surface.

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